METERS, MONITORS, PUMPS

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OBJECTIVES

- Discuss self management blood glucose monitoring (SMBG) and goal of BG, A1C
- Discuss SMBG and meter use
- Discuss Continuous Glucose Monitoring (CGM)
- Discuss Insulin Pumps
- Discuss Insulin Pumps and Integration of CGM
Glucose Monitoring

WHY???

- Assists the healthcare provider and patient to determine if the glycemic target is being met and if the current medical regimen is being effective.
- Guides: prandial insulin dosages, diet, exercise, prevents hypoglycemia, and evaluates glycemic response based on exercise and diet.
- Important to know before driving and during acute illness.

TWO MAIN WAYS TO CHECK GLUCOSE LEVELS

1. SELF MONITORING OF GLUCOSE LEVELS - METERS
2. CONTINUOUS GLUCOSE MONITORING - CGM/SENSORS
SMBG (self monitoring of blood glucose)– important for patients to receive ongoing Diabetic Education to ensure:

- Proper use of meter.
- Method of obtaining blood sample.
- Interpretation of results for possible adjustment of medication, diet, and behavior based on reading.
- And give support to the patient to avoid obstacles that may prevent patient from achieving goals.

Clinical trials have shown positive outcomes for patients on insulin with intensive glycemic control:

- Decreased risk of complications
- Lower A1C results

How and When Should SMBG be Used?

Pts on insulin:

- Check 2 or more times a day
- Before all insulin injections
- More frequent if glycemic target not met or frequent hypoglycemia (3am, after meals)
- Before driving

Not on insulin:

- Should begin at diagnosis and be individualized-depending on regimen
- Should use data to determine goals of FBG or PPBG
- Assists to modify both medication and behavior
ADA Glucose Monitoring Recommendations

Intensive insulin regimens- Pumps and MDI

Consider SMBG:
- Before meals
- Before snacks
- Before bedtime
- Before exercise
- Before critical tasks-ex. Driving
- Occasional postprandial
- Hypoglycemia
- After hypoglycemic treatment until normal range
- DM1- correlation between more testing and lower A1c’s

*no direct amount recommended by ADA


ADA Glucose Monitoring Recommendations

For those on basal insulin or oral agents:

- There is insufficient data as to when or how often to prescribe SMBG but data shows an inverse correlation between frequency and glycemic control. *

### Glycemic Goals: ADA and AACE Guidelines (non pregnant)

* Patient dependent

<table>
<thead>
<tr>
<th></th>
<th>ADA</th>
<th>AACE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPG</td>
<td>80-130</td>
<td>&lt;110</td>
</tr>
<tr>
<td>2 hour PPG (mg/dL)</td>
<td>&lt;180</td>
<td>&lt;=140</td>
</tr>
<tr>
<td>A1C</td>
<td>&lt;7.0%</td>
<td>&lt;=6.5%</td>
</tr>
</tbody>
</table>

*pregnancy, hypoglycemia, CVD, life expectancy, disease duration goal could be <6.5% or <8%

### Glycemic Goals in Pregnancy

<table>
<thead>
<tr>
<th>Blood Glucose</th>
<th>ACOG/ADA GDM Goals</th>
<th>ADA Goals - Pregnant Diabetics</th>
<th>AACE Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasting</td>
<td>&lt;=95 mg/dL</td>
<td>60-99 mg/dL</td>
<td>&lt;90-95 mg/dL</td>
</tr>
<tr>
<td>1 hour postprandial</td>
<td>&lt;=140 mg/dL</td>
<td>100-129 mg/dL</td>
<td>120-140 mg/dL</td>
</tr>
<tr>
<td>2 hours postprandial</td>
<td>&lt;=120 mg/dL</td>
<td>100-129 mg/dL</td>
<td>120-140 mg/dL</td>
</tr>
</tbody>
</table>

*patient dependent
GLYCEMIC GOALS in PREGNANCY

Due to increase red blood cell turnover in normal pregnancy, A1C is usually lower than those non pregnant.

**ADA A1C Recommendations**

<table>
<thead>
<tr>
<th>A1C Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>6% to &lt; 6.5%</td>
</tr>
<tr>
<td>&lt; 6 % if less risk of hypoglycemia (possibly on orals)</td>
</tr>
<tr>
<td>&lt; 7% if risk for hypoglycemia high</td>
</tr>
</tbody>
</table>

*patient dependent

ADA Recommendations for Glucose Control in Children/Teens

- The American Diabetes Association recommends the following blood glucose ranges for children with Type 1 diabetes.

<table>
<thead>
<tr>
<th>Age</th>
<th>Before meals</th>
<th>Bedtime-Overnight</th>
<th>Goal A1c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth-6 years</td>
<td>90-130 100-180*</td>
<td>90-150 110-200*</td>
<td>&lt;7.5%</td>
</tr>
<tr>
<td>6-12 years</td>
<td>90-130 90-180*</td>
<td>90-150 100-180*</td>
<td>&lt;7.5%</td>
</tr>
<tr>
<td>13-19 years</td>
<td>90-130</td>
<td>90-150</td>
<td>&lt;7.5%</td>
</tr>
</tbody>
</table>

* Old recommendations but can be used to individualize
Comparison of A1C and eAG

A1c  eAG (mg/dl)
4%  68
5%  97
6%  126
7%  154
8%  183
9%  212
10%  240
11%  269
12%  298
13%  326

eAG = Estimated Average Glucose  See: http://professional.diabetes.org/GlucoseCalculator.aspx

Depicted are patient and disease factors used to determine optimal A1C targets. **Individually based**

American Diabetes Association Dia Care 2015;38:S33-S40
“Pattern management is a systematic approach to help patients identify patterns in their blood glucose readings to determine whether changes are needed to optimize their glucose control.”


PATTERN MANAGEMENT

LOOK!!!!

IS THERE A PATTERN?

- MEAL TIME
- FOOD
- EXERCISE
- WORK
- STRESS
- ILLNESS
- INSULIN ADJUSTMENT
- SKIPPED MEAL
- MISSED MED
- MENSTRUAL CYCLE
- STEROID USE
PATTERN MANAGEMENT

Frequent SMBG taken:
• Review blood glucose levels
• Identifies patterns

- Identifies patterns of glucose levels, meals, meal times, exercise, work.
- Can show patterns of hyperglycemia, euglycemia, hypoglycemia daily so changes can be made by both the patient and provider.
- Can show insulin resistance, excessive hepatic glucose production, and lack of exogenous insulin coverage.

PATTERN MANAGEMENT - look at last 3-5 days

Is there a pattern that:
• happens each day at the same time?
• shows action time of insulin or oral meds?
• shows post meal hyperglycemia?
• shows fasting hyperglycemia?
• shows hypoglycemia?

IF SO-what do we do?
• Correct the hypoglycemia first
• Make small changes to determine what is working—too many changes at one time can be more confusing
• Counsel on meds, exercise, meals
Fingertips have been the most common area to obtain blood samples

Alternate site testing are allowed on some meters:

- Sites: Upper arm or forearm, palm of the hands, thighs or calves
- May give reading 20-30 min ago
- May give slightly lower results due to possible sample venous blood rather than capillary; or when BG changes rapidly.
- Recommended to be consistent with site, otherwise more fluctuations when switching finger to other site

Remember to use universal precautions w each patient- change out lancets/gloves

Demonstrate how to test, how to use control solution, meter set up, and how to log

Logging with date, time, BG, and med/insulin dosage

BE SPECIFIC- how many times a day to test and when?
BG Testing

ERRORS can be caused by
- Expired strips
- Wrong strip/wrong meter
- Storage of strips- bathroom or open to air
- Strips defective- bent
- Not enough blood
- Control not performed
- Alcohol/wet hands
- Unclean hands
- Just ate-

Patient Barriers

- Avoid terms of “good” or “bad” blood sugar results as pt may feel they are “bad” with a “bad” result
- Painful- help show different areas to obtain BG, check depth level on lancet, be sure lancet has been changed as gets dull
- Offer timing of checks that may suit there day ex: work nightshift so “dinner time” may be in morning
- Log: ask at to keep 3-5 days worth, prior to visit as every day logging can be tedious
- Assist patient in making goals, but realistic goals.
- Stress importance of BG data is intended to help make medical decisions about their regimen - not as judgment of their ability to take care of themselves.
- Emphasize they are the ones in control and provider can only offer advice.
- Ask for input of what their goals are what can be done to achieve them.
- Ask what may be barriers for them and assist with solution.

**BG and A1c readings**

<table>
<thead>
<tr>
<th>FALSE HIGH A1C</th>
<th>FALSE LOW A1C</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC turnover low</td>
<td>RBC turnover rapid</td>
</tr>
<tr>
<td>Pts with iron, Vit B 12, folate deficiency anemia's</td>
<td>Hemolysis or anemia</td>
</tr>
<tr>
<td>CKD</td>
<td>Pts treated for iron, Vit B12, folate def or treatment with erythropoietin</td>
</tr>
<tr>
<td>Thyroid replacement</td>
<td>CKD</td>
</tr>
</tbody>
</table>
Factors that Affect Meter Performance

- HCT

- High Concentrations:
  - Acetaminophen
  - Uric acid
  - Ascorbic acid (Vitamin C)
  - Salicylates

Pattern Management
CASE 1

Type 1 diabetic:
Lantus: 24 units in morning 9am
Novolog:
- 6 units with breakfast
- 8 units with lunch
- 12 units with dinner

Upon questioning:
- Eats oatmeal for breakfast with glass of milk
- Eats usually sandwich for lunch
- Big dinner: low cho, high protein and mostly veg.
- No snack before bed

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before breakfast</td>
<td>193</td>
<td>186</td>
<td>215</td>
</tr>
<tr>
<td>Before lunch</td>
<td>287</td>
<td>198</td>
<td>227</td>
</tr>
<tr>
<td>Before dinner</td>
<td>162</td>
<td>147</td>
<td>142</td>
</tr>
<tr>
<td>Before bed</td>
<td>125</td>
<td>102</td>
<td>119</td>
</tr>
</tbody>
</table>
**Type 1 diabetic:**
- Lantus: 24 units in morning 9am
- Novolog:
  - 6 units with breakfast
  - 8 units with lunch
  - 12 units with dinner

**Pattern:**
- Elevated in the am
- Elevated pre lunch
- Good pre dinner, bedtime

**Solution:**
- Increase lantus
- Split lantus?
- Increase breakfast dose
- Teach CHO counting
- Give correction scale

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</table>

**Type 2 diabetic:**
- Metformin 1000 mg po bid
- Glipizide 10 mg po bid

**Upon questioning:**
- Eats only “Nabs” for lunch, not hungry
- Has been weeding in garden
-Feels shaky around 80
- Gets meals on wheels

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<th>Tuesday</th>
<th>Wend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before breakfast</td>
<td>60</td>
<td>83</td>
<td>74</td>
</tr>
<tr>
<td>Before lunch</td>
<td>100</td>
<td>68</td>
<td>83</td>
</tr>
<tr>
<td>Before bed</td>
<td>81</td>
<td>79</td>
<td>103</td>
</tr>
</tbody>
</table>
CASE 2

Type 2 diabetic:
Metformin 1000 mg po bid
Glipizide 10 mg po bid

Problems:
- Hypoglycemia – too many
- Exercise
- On sulfonylurea and not eating consistently
- One meal a day guaranteed
- Too much medication

Solutions:
- Increase intake especially with lunch, exercise
- Snack with exercise/gardening
- Decrease glipizide or stop it depending on A1c

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<td>79</td>
<td>103</td>
</tr>
</tbody>
</table>

Continuous glucose monitoring (CGM) in conjunction with intensive insulin regimens can be a useful tool to lower A1c in selected adults with type 1 diabetes.
**Hypoglycemia Prevention and Treatment**

- Prevention! Prevention! Prevention!

- "15/15" rule:
  - 15 g of CHO, recheck glucose in 15 minutes
  - Repeat treatment if continued hypoglycemia (with fingerstick) after 15 minutes after initial treatment - want close to 100 mg dL

- Prescribe glucagon if risk of hypoglycemia.
  - Train family members, caregivers in administration.

- Advise those with hypoglycemia or ≥ 1 severe hypoglycemic episode(s) to raise glycemic targets.

SMBG = self-monitoring of blood glucose.

ADA. Diabetes Care. 2015; 38 (suppl.):S11-S63.

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**CGM-Continuous Glucose Monitoring**

- Measures glucose content of interstitial fluid which correlates to plasma glucose.
- Accessed through a subcutaneous needle sensor

- Measurements may not correlate due to lag time- WHY?
  - Glucose moves from vessels and capillaries first then interstitial fluid.

*(some studies showed hypoglycemia readings are less accurate vs. hyperglycemia)*
**CGM-Continuous Glucose Monitoring**

<table>
<thead>
<tr>
<th>Personal</th>
<th>Professional</th>
</tr>
</thead>
<tbody>
<tr>
<td>-&quot;Real time&quot; glucose shown</td>
<td>-Blind study</td>
</tr>
<tr>
<td>-6-7 day use</td>
<td>-Needs downloading</td>
</tr>
<tr>
<td>-Alarms-hypoglycemia and hyperglycemia</td>
<td>-3-5 day use with records of BG, food,</td>
</tr>
<tr>
<td>-Predicts BG, shows trends</td>
<td>medications, exercise</td>
</tr>
<tr>
<td></td>
<td>-No alarms</td>
</tr>
</tbody>
</table>

**DOES NOT ELIMINATE FINGER STICKS!!!**

- Need to calibrate
- Should be checking pre meal, before dosing insulin, before driving, when low
- “FDA has not yet approved these devices as a sole device to monitor glucose.” -

Candidates:
- Frequent hypoglycemia/unawareness
- Over age of 2
- On or off insulin
- Motivated patients-will test
- Preconception/pregnancy
  - Hasn’t been evaluated in pregnancy or HD

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DEXCOM

- 7 day use
- Access real time BG readings
- Trends—1, 3, 6, 12, 24 hour graph
- Alarms—personal high/low
- Calibrate every 12 hours (with any meter-same)
- Sites abdomen or upper buttocks
- DexCom Data Manger and Home Clarity software—can be shared w 5 people w follow app

- Don’t use in MRI, CT scan or diathermy
- Tylenol/Excedrin Xtra Strength contraindicated—as may falsely raise readings.

G4- transmitter and can be shared w iPhone but needs receiver
- new transmitter every 6 months
G5-transmits directly to iPhone
- new transmitter every 3 months
- G4 Platinum- peds 2-17yo

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DEXCOM G5 Mobile

- Can be used for those 2 and older
- Only FDA approved for treatment decisions
- Still need to calibrate every 12 hours (2x/day)
- STILL check finger sticks for calibration, unsure of symptoms, possible stacking of insulin, exercise.
- Acetaminophen may raise numbers
- Belly and upper buttocks only
- January 13, 2017-possible coverage now by Medicare—still under development
Which Dexcom is right for me?

Experience Dexcom your way
Experiencing the benefits of Dexcom Continuous Glucose Monitoring (CGM) has never been easier. Available in both stand-alone CGM systems and CGM-enabled integrated insulin pumps, patients can now choose the Dexcom product that suits them best.

<table>
<thead>
<tr>
<th>Product Name</th>
<th>System Name</th>
<th>Receiver or Display Device</th>
<th>Transmitter (in pkg)</th>
<th>Sensor</th>
<th>Manual Lursal</th>
<th>Share (iOS)</th>
<th>Follow (for a fee)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sofsenser Medtronic Revel/Guardian</td>
<td>3 day use (professional use)</td>
<td>Dexcom G4 Mobile</td>
<td>Dexcom G6 Mobile / G7 PLATINUM* sensor</td>
<td>Dexcom G5 Mobile / G7 PLATINUM* sensor</td>
<td>Dexcom G5 Mobile / G7 PLATINUM* sensor</td>
<td>Dexcom G5 Mobile App*</td>
<td>Dexcom Follow App*</td>
</tr>
<tr>
<td>Enlite sensor</td>
<td>6 day use</td>
<td>Dexcom G4 PLATINIUM CCM with Share (3 months)</td>
<td>Dexcom G4 PLATINIUM with Share (3 months)</td>
<td>Dexcom G4 PLATINIUM (3 months)</td>
<td>Dexcom G4 PLATINIUM (3 months)</td>
<td>Dexcom G4 PLATINIUM Sensor</td>
<td>Dexcom G4 PLATINIUM Sensor</td>
</tr>
<tr>
<td>530G pump, 630G pump</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Shows readings every 5 minutes
- Shows data from past 3, 6, 12, 24 hours
- Abdomen use only, needs to be at least 1-2” away from pump site
- Calibrate- not when low, exercise, just ate
  - 2 hour warm up period
  - Calibrate at 2 hours, then 6 hours, every 12 hours afterwards
  - CareLink personal- downloading software
  - Automatic suspension of pump when low threshold is met will alarm and suspend up to 2 hours w 530G pump

CGM-MEDTRONIC

Sofsessor Medtronic Revel/Guardian- 3 day use
(professional use)
Enlite sensor- 530G pump, 630G pump
- 6 day use
- Shows readings every 5 minutes
- Shows data from past 3, 6, 12, 24 hours
- Abdomen use only, needs to be at least 1-2” away from pump site
- Calibrate- not when low, exercise, just ate
  - 2 hour warm up period
  - Calibrate at 2 hours, then 6 hours, every 12 hours afterwards
  - CareLink personal- downloading software
  - Automatic suspension of pump when low threshold is met will alarm and suspend up to 2 hours w 530G pump
CGM-MEDTRONIC

- Minimed Connect App – can connect to iPhone, iPod touch, Android (530G, Revel pumps)
  - Can share blood sugar info w family/friends by automatic uploads to Carelink Personal software, text messages about high/low bld sugars
  - Additional cost for uploader $99

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CGMS Caveats per AACE

Treatment goals should be individualized based on:
- Current glycemic state
- Risk for hypoglycemia
- Cardiovascular and microvascular comorbidities.
CGMS BILLING- Professional or Personal use

95250-TECHNICAL
BILL AT TIME OF HOOK UP

*Done under supervision of provider
- Subcutaneous sensor for minimum of 72 hours
- Sensor placement/hookup
- Calibration of monitor
- Pt education
- Disconnection
- Data download recording

95251-INTERPRETIVE

*Must be completed by Physician, NP, PA
- Review
- Interpret
- Report data
- Must be minimum of 72 hours
- No more than 1 time a month can bill
- **Does not need to be face to face but report needs to be generated – can be remote

***Currently no Medicare/Medicaid coverage and coverage is insurance specific

INSULIN PUMPS- CSII

Candidate:
- Self motivated
- Monitors 4-6 times a day
- Self desire for good management
- Has support
- Expectations are realistic
- Hypoglycemic unawareness
- Insulin sensitive
- Pregnant- as macrosomia is due to hyperglycemic excursions
INSULIN PUMPS - CSII

- Mimics the pancreas
- Programmed to deliver insulin slowly to the body through a needle or plastic cannula.
- Analog or U500 can be used
- Uses one injection site for 2-3 days
- Flexible lifestyle and mealtimes

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INSULIN PUMPS

**BASAL**

- Steady, slow continuous 24 hour insulin delivered by pump to mimic pancreas-basal rate
- Hourly insulin that works between meals and overnight while suppressing glucose production
- Multiple basal rates can be programmed hour by hour from as little 0.025 u/hr
- This will take the place of basal insulin given by injection

  ex: NPH, Levemir, Lantus

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**BOLUS**

- Insulin broken down to cover 2 things
  1. Food coverage - meals, snacks
     - By cho counting, or fixed amt
     - Ex: 1 unit covers every 10 gms of food eaten
     - Ate 60 gms = 6 units
  2. Correction coverage -
     - How much BG drops w 1 unit of rapid acting insulin
       (Correction factor or sensitivity)
     - Ex: 1:50 - 1 unit drops BG by 50 points
Target and Correction

- **Target**: BG goal where you want BG to be
- **Correction is calculated by**: 
  \[ \text{BG} - \frac{\text{target}}{\text{sensitivity}} = \text{amt correction needed} \]

Ex:
Target BG: 100  
Current BG: 250  
Sensitivity: 50

\[
250 - \frac{100}{50} = 3 \text{ units correction to get target of 100}
\]

BASAL

- Type 1 can not go without basal insulin
  - May be off pump for 1-1.5 hours before seeing elevation. BG rises 45 mg/dL/hr after no insulin
  - Can lead to DKA if no basal for a period of time

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Basal Level (units/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 AM – 5 AM</td>
<td>0.70</td>
</tr>
<tr>
<td>5 AM – 8 AM</td>
<td>0.50</td>
</tr>
<tr>
<td>8 AM – 1 PM</td>
<td>0.60</td>
</tr>
<tr>
<td>1 PM – 10 PM</td>
<td>0.50</td>
</tr>
<tr>
<td>10 PM – 12 AM</td>
<td>0.60</td>
</tr>
</tbody>
</table>

BASAL

- Change basal rates 3-8 hours before you want it to work - think ahead
- Adjust basal from 0.05 to 0.1 unit/hr but if very sensitive can go up by 0.025u/hr
- Usually 50-60% of TDD
- Most Type 1 seem to need 2-4 different rates
- Basal rates should be similar in rate amts
  Ex: 0.5 then increase to 1.2? BIG JUMP - recheck

BASAL TOO HIGH

Are there lows:
- when a meal or snack is missed?
- overnight?
- before breakfast?
- lows more than 4 hours after bolus given?
- with wt loss?
- when the basal insulin is more than 50-60% of TDD?
BASAL TOO LOW

- BG elevates with skipped meal.
- FBG elevated and no bedtime snack.
- BG frequently elevated.
- Frequent correction needed.
- Basal is less than 50-60% of TDD.

BOLUS

- Can deliver bolus by 3 ways
  - 1. Normal: delivers all insulin at that time
  - 2. Square-wave: delivers insulin over a period time set by pt
     - Good with pts w gastroparesis, banquets, high fat meal or grazing over a specific period of time
  - 3. Dual wave: some insulin given now and some over a period of time (part normal and square wave)
     - Ex: Sugar elevated before banquet meal - can give upfront 70% now (to correct elevated BG) and give the remaining amt over an hour (30% left)
     - Most pts use for high fat meals like Mexican, PIZZA, french fries – but for how long is not exact
BOLUS “Wizard” or Calculator

- Allows for exact calculation of insulin rather than fixed dose. ex: 1.85 vs. 2.0
- Considers amt of cho eaten and current blood sugar when suggesting a dose.
- Considers “insulin on board” or leftover insulin from previous bolus.
- Bolus calculation considers:
  - Cho amt, BG before the meal, CHO amt of food, target BG
- Works only if settings are correct, the cho count was correct, and if BG was entered.
Insulin on Board

- IOB- unused amount of insulin
- Shows how much insulin is left from pervious bolus * if pt count cho accurately
  - Helps to avoid stacking
  - Improves bolus accuracy
  - If pt goes low with IOB = hint that settings need to be changed
  - Most set for 3-4 hours but can be changed
    - Pregnant pt- needs to have correction sooner to avoid PP hyperglycemia
    - Pt on steroids

PUMP Formulas- for Adults

- Total daily dose (TDD) = Wt (kg) x 0.53 = or 25% of total of MDI *
- Carbohydrate ratio (CIR or 1:C ratio) 500 gms divided by TDD
- Correction factor = 1700 adults or 1800 children divided by TDD
- Basal Insulin =0.48 x TDD or (approx 50% of TDD)

PUMP – Infusion sets

Has 2 parts: insertion sets and reservoir

Insertion sets include:
- **Tubing** – leads from pump to site on pt
  - 23 inch or 43 inch tubing
- **Catheter or insertion set** (part that is “inserted” into the skin metal or plastic)
- **Cannula lengths:**
  - 12 mm for larger adults
  - 10 mm for adults
  - 8 mm for children/thin adult
  - 6 mm for infant

Reservoir:
- Container that holds the insulin inside the pump
  - Can hold 200-480 units of insulin depending on pump.
PUMP TRAINING

EDUCATION IS KEY!!!

CDE, RD: crucial for ongoing education on CHO counting, management of BG, problem solving, and how to manage: exercise, sick days, travel, or if pump malfunctions.

Education includes:
- Pre pump education – testing 4 times a day, CHO counting
- Pump start up
- Follow up, management, and ongoing education with support.

Insulin Pump Problems

- Site or tubing occlusion, or bubbles in tubing – may lead to DKA
  - BG >250 x2 row need to change all tubing, reservoir, and insulin and give injection.
  - Monitor BG frequently and urine ketones
  - Contact provider if nausea/vomiting, ketones
- Illnesses, medications
- Site infections, tape sensitivities, hematoma, not changing site every 2-3 days
- Pump malfunctions
Insulin Pump Problems

- Increase or decrease in insulin needs - wt loss/gain
- Patient understanding
- Patient adherence - not changing site, not checking BG, not utilizing CHO wizard, forgetting to bolus
- Settings are incorrect
- Mechanical support # usually on back of pump

“The Pump is only as good as the user who uses it!”

Emergency Kit With Pumps

- Blood sugar testing equipment - meter, strips, lancets, batteries
- Site and reservoir sets
- Back up insulin - analog and basal
  - Syringes or pens
- Glucagon Emergency Kits - hypoglycemia
- Snacks
- Medic Alert
- Written settings/regimen if pump malfunctions
- Contact information if emergency
- Providers name and number
INSULIN PUMPS

- Following slides are from a non-biased website for comparisons of insulin pumps

- Focus on the most common seen at MUSC:
  - Animas, T-Slim, Medtronic, Omnipod, and V-Go
    (Accucheck – going out of business)

  All pumps basically do the same thing:
  delivers insulin via basal, bolus
  - Bells and whistles are different
  Ex: waterproof, battery vs. rechargeable, tubing/no tubing, delivery increments, amt of insulin held, CGM combination and now iPhone/share compatible

Tandem T-slim

Advantages:
- Bright, full-color touch screen
- Modern, high-tech appearance
- Compact, thin dimensions
- Rapid numeric entry, fastest bolus entry
- Cartridges hold 300u (t:slim); 480u (t:flex)
- Can calculate boluses up to 50 units (60 on Flex version)
- Site-change reminder w/customizable day & time
- Graphic on-screen history display
- Carb counting calculator
- Temp basal up to 250%, 72 hrs

- Can set duration of insulin action in 1-minute increments
- IOB & time remaining displayed on home screen
- Missed bolus reminders customizable by day of week
- Alert for high temperatures which may spoil insulin
- Secondary basal programs linked with secondary bolus calculation parameters
- Web-based download software
- Compatible w/leur-lock infusion sets
- Minimal insulin movement with changes in altitude
- Now with Dexcom

Combines Dexcom G4 Platinum CGM.
Can see BG readout on pump and with transmitter can share data to iPhone

Possible Drawbacks:
- Small buttons can be difficult to activate; screen goes blank if buttons missed 3x
- Unlock procedure required to perform any programming
- No integrated clip (must put in a case that has a clip)
- Tubing connector looks “medical,” can snag on clothing
- Basal & bolus settings in same time slots; may take several steps to edit
- All delivery cancelled during cartridge change-out & priming
- Extra confirmation steps with all programming
- Weak vibrate mechanism
- Manufacturer relatively new in pump industry
- Requires charging 1-2x/week
- No formal in-warranty upgrade policy
Omnipod

**Advantages**
- Reduced up-front costs
- Can program through clothing from a few feet away
- Discrete pump size (compared to other pumps)
- No tubing (minimizes wasted insulin, no tangling/snagging, less awkward, no air pockets, no siphoning effects)
- No disconnecting/reconnecting means no missed/lost insulin
- Simple, automated cannula insertion minimizes pain, reduces “human errors”, creates more site options
- Forced pod change reduces chances for lipodystrophy & absorption problems
- Pump is fully watertight
- Temp basal and boluses can be customized/preset
- Freestyle meter built into handheld programmer
- Can customize programming text without PC linkup
- Large color screen w/full-sentence text and graphing capability
- Only 2 parts; convenient for travel

**Possible disadvantages**
- Somewhat bulky programmer
- Pod creates a “bulge” on the skin
- Cannot enter boluses or make setting changes without programmer
- Cannot do programming or editing while bolus is delivering
- Only one cannula orientation/length; may not work for all body types
- Max reservoir volume 200u; minimum fill amount 85u
- Pod stops working after 72 hours (plus grace period)
- Handheld will not calculate bolus if BG < 50
- Dislodged/clogged cannula requires complete pod replacement
- “Disconnection” requires complete pod replacement
- Pod does not have vibrate option
- Must suspend when changing basal settings
- Temp basal limited to 12 hours max
- Not covered by all 3rd party payors
- Insulin-to-carb ratios in whole-numbers increments only
- Loss (or malfunction) of remote/PDM renders pod non-programmable (delivers basal only)
Animas Vibe

Advantages
- Displays data from Dexcom G4 CGM
- 35-Unit maximum bolus
- Fully water-tight
- Very bright, full-color screen; easy to read
- AA Lithium battery lasts 6-8 weeks
- User-defined timeout setting
- User-defined occlusion sensitivity
- User-defined bolus delivery rate
- Customizable tune for alerts
- Cartridges very easy to fill without air bubbles
- Pump and CGM data downloadable to Diasend web-based software
- Strong integrated metal clip
Possible disadvantages:
- Does not link with blood glucose meter
- Utilized older-generation Dexcom data algorithm
- Battery change requires re-priming
- Insulin-to-carb ratios in whole-number increments only
- Cannot see cartridge inside pump
- Extra button presses required with most standard programming
- No data averages or statistics generated on pump screen
- Cannot recall blood glucose or carb history on pump screen
- Insulin On-Board is not subtracted uniformly from boluses
- 200-Unit cartridge limit
- Cursor (scroll) speed difficult to master
- Bolus delivery may be too rapid for those taking large doses


Medtronic MiniMed
18000 Devonshire St.
Northridge, CA 91325-1219
Phone:  800- 646-4633
E-Mail:  www.minimed.com
**Medtronic 530G with Enlite**

**Advantages:**
- Large, secure, long-established company
- Industry leader in R & D
- Pump comes with integrated Enlite CGM system; data displayed on pump screen
- Automatic basal shutoff when low glucose detected by sensor (may help prevent severe hypos)- SmartGuard Technology
- Minimed Connect App
- Quick/simple bolus programming
- Slim/streamlined attachable clip
- Optional remote control (@ addl. cost)
- Accepts radio communication from multiple blood glucose meters
- Easily downloadable to online Carelink program
- Can set I:C ratios in .1g increments
- Generates insulin/carb/BG statistics

**NEW:**
- Remote monitoring to any # of people
- Info from pump to Uploader then transfers info to iPhone/iPod and CareLink automatically

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**MiniMed Connect**

**NEW:**
- Remote monitoring to any # of people
- Info from pump to Uploader then transfers info to iPhone/iPod and CareLink automatically
Medtronic 630G with Enlite

- Color screen
- Waterproof – 12 feet for 24 hours
- Stores up to 10 hours of missed glucose readings
- CGMS can not be set up with mobile device
- Remote via contour next meter that comes with pump *
- Predictive alert up to 30 min before low
- SmartGuard technology- alarm and turns self off if met low threshold if no response to alarm
- Approved for only those over 16 yrs of age

Possible Disadvantages:
- Not water-tight- but new 630G is
- Must purchase Enlite CGM system along with pump
- Low-contrast LCD screen
- Must use proprietary infusion set tubing
- Must purchase CGM system along with the pump
- Slow bolus delivery
- No food database
- Must pay for loaner/backup pumps
- Customer service may not be prompt or friendly
- Holds 180 units; 300-unit version is slightly larger
- Insulin-on-board only deducted from correction boluses
- Duration of action set in whole-hour increments
- CGM system accuracy, longevity, transmission range, ease of use considered inferior to competitors
- CGM & pump alerts may not be loud enough for some to hear
- Data from pump/CGM not downloadable to any program other than Carelink & Carelink Pro

MiniMed
NEW!!! Medtronic 670G with Guardian Sensor 3

- First “Hybrid Closed Loop System”
- Will automatically increase/decrease basal insulin based on CGM readings and suspend insulin based on low threshold
- New Sensor w 7 day use, need to calibrate 3x day
- 14 years and older w DM1
- Starting to ship SPRING 2017

NOT intended for those that:
- Are under 7
- Use less than 8 units/day
- Pregnant
- Impaired kidney function

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Roche Accucheck Combo

Advantages:
- Smart scrolling
- Intelligent bolus adjustment based on effect of bolus insulin
- Boluses can be adjusted in percentages for events such as exercise
- Full pump programming via linked meter/remote via Bluetooth communication
- Bright, full-color meter screen
- History displayed as graphic reports on meter screen
- Basal increments of .01u/hr
- Holds 315u insulin
- Sensitive occlusion detection
- Site change reminder at 48 or 72 hour

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**NO LONGER BEING SOLD IN THE US**
Possible disadvantages:

- Must use linked meter to perform bolus calculations
- Can only link 1 meter per pump
- Minimum basal rate: 0.05u/hr
- Must change meter before starting a bolus
- Must enter cartridge fill amount manually
- Alarms at conclusion of temp basal
- Need computer/software to change temp basal parameters
- All bolus calculation settings in same time slots; somewhat bulky
- Cartridges can be difficult to fill without bubbles
- Must stop pump to change cartridge

Accucheck

V-Go – Patch Pump

Valeritas Inc.
750 Route 202 South, Suite 100
Bridgewater, NJ 08807
Phone: 908-927-9920
E-mail: www.valeritas.com
Valeritas V-Go
- For DM 2 only
- Preset basals and on demand boluses – 2 unit @ click

3 Options:
- V-Go 20 - 20 unit basal 24 hr (0.83 U/hr)
- V-Go 30 – 30 unit basal 24 hr (1.25 U/hr)
- V-Go 40 – 40 unit basal 24 hr (1.67 U/hr)

*All on demand bolus same amt of 36 units in 2 unit increments every 24 hours however
(18 clicks a day = 36 units bolus daily only)
Celebrities with Diabetes

- Tom Hanks – actor
- Nick Jonas – singer
- Halle Berry – actress
- Kris Freeman – Olympian skier
- Salma Hayek – actress
- Paula Deen – chef
- Anne Rice – author
- Mary Tyler Moore – actress
- Nicole Johnson – Miss America
- Morgan Freeman – actor

- Type 2
- Type 1
- Type 1
- Type 1
- Gestational
- Type 2
- Type 1
- Type 1
- Type 1
- Type 2
Blood Glucose Monitors

- **Abbott**
  - 1-800-527-3339
  - www.abbottdiabetescare.com
- **AgaMatrix**
  - 1-866-906-4197
  - www.wavesense.info
- **Arkray**
  - 1-800-566-8558
  - www.glucocardusa.com

Miss Idaho wears an insulin pump
Blood Glucose Monitors

- Bayer
  - 1-800-348-8100
  - www.simplewins.com
- Bionime
  - 1-888-481-8485
  - www.bionimeusa.com
- Diabetes Supply of Suncoast
  - 1-866-373-2824
  - www.pharmasupply.com

DIDGET™
Plugs into Nintendo

Blood Glucose Monitors

- Diagnostic Devices
  - 1-800-243-2636
  - www.prodigymeter.com
- Entra Health
  - 1-877-458-2646, ext. 3
  - www.myglucohealth.net
- Fifty50 Medical
  - 1-800-746-7505
  - www.fifty50.com
Blood Glucose Monitors

- Fora Care
  - 1-888-307-8188
  - www.foracare.com/usa

- Gluco Com
  - 1-800-678-1446
  - www.glucocom.com

- Home Diagnostics
  - 1-800-342-7226, ext. 3300
  - www.homediagnositics.com

Blood Glucose Monitors

- Infopia
  - 1-888-446-3246
  - www.infopiusa.com

- LifeScan
  - 1-800-227-8862
  - www.onetouchdiabetes.com

- Nova Biomedical
  - 1-800-681-7390
  - www.novacares.com
Blood Glucose Monitors

- Roche
  - 1-800-858-8072
  - www.accu-chek.com/us

- US Diagnostics
  - 1-866-216-5308
  - www.usdiagnostics.net

- WalMart
  - 1-800-631-0076
  - www.relion.com/diabetes